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ABSTRACT

The major purpose of this study was to examine bimodal coordination of featural stimuli in infancy. Specifically of interest was infant sensitivity to the auditory and visual combinations that characterize male and female stimulus configurations. A total of 27 male and 27 female subjects of 3, 6, and 9 months of age participated in the study. Infants were positioned approximately 12 inches from two television screens mounted 6 inches apart. Four 17-second simultaneous presentations of faces were made. Within each age group, one-third of the infants heard one of three auditory stimuli: either a male or female voice reciting a poem, or music. Two observers using a continuous event recorder noted the visual stimulus infants preferred. Results revealed that, in comparison with the other two age groups, 6-month-old infants looked significantly more at the male and female face during respective male and female voice conditions. In contrast, 3-month-old children looked significantly more at the female face regardless of the auditory condition. The 9-month-old infants exhibited a nonsignificant tendency to look at the opposite-sex face during male and female voice conditions. It was concluded that the study demonstrates the ability of infants, by the sixth month of life, to recognize male and female stimulus configurations across auditory and visual modalities. (RH)

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Infants' Bimodal Recognition of Human Stimulus Configurations

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Abstract

This study tested infants' ability to match male and female attributes across auditory-visual dimensions. 54 3-, 6- and 9-month-old infants (27 males, 27 females) were shown a videotaped male and female face and simultaneously heard either: 1) a male voice reciting a poem; 2) a female voice reciting the same poem; or, 3) music. Results revealed that the 6-month-old infants demonstrated significantly more looking at the male and female face during the male and female voice conditions, respectively. In contrast, the 3-month-old group looked more at the female face regardless of the auditory condition, while the 9-monthers exhibited a non-significant tendency to look at the opposite-old face during the male and female voice conditions.

Infants' Bimodal Recognition of Human Stimulus Configurations

Following research which demonstrated the young infant's competence in processing information through single modalities (e.g., Eimas, Siqueland, Jusczyk & Vigorito, 1971; Fantz, 1961), investigators have directed their attention to bimodal processing in infancy, particularly across auditory and visual channels. Earlier studies which indicated that infants simultaneously process sights and sounds (e.g., Horowitz, 1974; Mendelson & Haith, 1976) led to more complex and exciting questions, such as the extent to which (and at what age) babies organize auditory and visual stimulus configurations.

In general, studies exploring this issue have focused upon either the spatial, temporal or featural aspects of auditory-visual organization. With respect to the former, Aronson & Rosenbloom (1971) found that 1-2 month-old infants became distressed upon seeing their mothers talking to them, but with their voices spatially displaced through a microphone and speaker. Temporal relationships between auditory and visual stimuli have primarily been explored by Spelke (1976; 1979); her data suggest that 4-month-old infants are sensitive to temporal synchrony between visually- and acoustically-specified events.

In contrast to spatial and temporal integration of auditory and visual information, featural coordination has received considerably less research attention. In one of the few studies to examine this issue, Cohen (1974) assessed the reactions of 5- and 8-month-old babies to the presentations of face-voice matchings and mismatchings of their mother and a stranger; this author's findings were equivocal, with only some of the 8-monthers appearing to exhibit

specific auditory-visual expectations, and none of the 5-month-olds doing so. Similarly, Spelke and Owsley (1979) found that 8-month-old infants, but not 5-monthers, matched mother and fathers' voices with the appropriate corresponding faces. Overall, the late appearance of featural bimodal integration suggested by both Cohen (1974) and Spelke and Owsley (1979) is somewhat surprising, especially given the early ages at which spatial and temporal organization across modalities has been reported (e.g., Aronson & Rosebloom, 1971; Spelke, 1976, 1979).

The major purpose of the present study was to further examine bimodal coordination of featural stimuli in infancy; specifically of interest was infants' sensitivity to the auditory and visual combinations which characterize male and female stimulus configurations. Infants' awareness of "maleness" and "femaleness" is not only of interest in itself, but also is a good example of how infants come to organize information across modalities. Still, few studies have addressed this issue. In one such study, Francis, Self and Biscoe (1980) found that 3-month-old infants matched female voices and faces, but not male voices and faces. In contrast, Miller and Horowitz (1980) reported, using a group of 8-month-olds, that these babies matched voices and faces, but only in response to male stimuli. By utilizing different age groups of infants, the current study attempted to clarify the meaning of this earlier work.

Method

The subjects for this study were 3- (mean age = 13.2 weeks, range = 11-44 weeks), 6- (mean age = 25.1 weeks, range = 23.26 weeks) and 9- (mean age = 36.4 weeks, range = 34.38 weeks) month-old infants; all of the infants were fullterm and had experienced no serious postnatal problems. Of the 85 infants tested,

31 failed to remain in an alert, non-active state (e.g., Brazelton, 1973) for the procedure, and were therefore not included in the final sample. Attrition was particularly characteristic of the 9-month-olds, as only 18/38 (47%) made it through the procedure; in contrast, 18/26 (69%) of the 6-monthers and 18/21 (86%) of the 3-monthers did so. Therefore, the final sample consisted of 54 infants, with each age group having 9 males and 9 females.

For the experimental procedure, infants were placed by themselves in a curtained area in an infant seat or high chair; parents observed the procedure through an opening in the curtain. Infants were positioned approximately 12 inches from a partition on which two television screens were mounted; these screens were used to present the male and female faces via a videotape recorder. These faces, approximately 6 inches apart, were similar with respect to contrast; also, each infant was presented with two sets of male and female face-voice combinations.

The procedure began immediately after the parent had placed the infant in the infant seat/high chair and stepped out behind the curtain. By raising and lowering a black curtain, four 17-second presentations of the faces were made; within each age group one-third of the infants heard, through a centrally-located speaker one of three auditory stimuli: 1) a female voice reciting a poem; 2) a male voice reciting the poem; or, 3) music (the control condition). A trial (indicated by the beginning of the videotape) began when the infant looked at one of the stimuli. In order to control for a position effect, the position of the faces was switched on each trial. Two observers watched the infants from openings above the television screens and recorded, using a con-

tinuous event recorder, which stimulus the infants were looking at (as well as when the infant was looking away). Interobserver reliability was computed by dividing the number of seconds the observers agreed with respect to where the infant was looking by total number of seconds; this reliability exceeded .82 for all of the subjects (mean reliability = .86).

Results

Tables 1 and 2 contain the mean number of seconds spent by the three age groups looking at the male and female face during each of three auditory conditions. As an examination of these tables suggests, only the 6-month-old infants in the present study appeared to look at the male and female face more during the male and female voice conditions, respectively. In contrast, the 3-monthers looked at both faces approximately the same amount regardless of the voice condition. Finally, with respect to the 9-month group, these infants actually looked more at the opposite-sex face during the male and female voice conditions; this tendency was particularly apparent for the female face during the male voice condition.

In order to test the significance of these findings, two 3(Age) X 3(Auditory Conditions) ANOVA's were performed; dependent measures were the total time spent looking at the male and female face, respectively. The analysis of the male-face fixation scores revealed a significant Age X Auditory Condition effect, $F(4, 53) = 5.78$, $p < .001$. Individual comparisons were performed and confirmed what is suggested by the means in Table 1; specifically, 6-monthers were observed to look more at the male face during the male voice condition as compared to the female and music conditions. No other comparisons were significant.

Comparable findings were demonstrated by the analysis of fixation time at the female face. This analysis also revealed a significant Age X Auditory Condition effect, $F(4, 53) = 8.25$, $p < .0001$. Again, individual comparisons were conducted and indicated that, as suggested in Table 2, the 6-month group spent significantly more time looking at the female face during the female voice condition as compared to the male voice condition. No other comparisons were significant.

As an examination of Tables 1 and 2 reveals, 1) differences existed in total looking time as a function of infant age; and, 2) the 3-monthers in this study appeared to look more at the female face regardless of the auditory condition. In order to test the significance of this first possibility, a one-way ANOVA was performed, with age as the independent variable and total fixation time as the dependent measure. A significant age effect was revealed by this analysis, $F(1, 53) = 12.71$, $p < .0001$; mean looking times for the 3-, 6- and 9-monthers were, respectively, 51.22, 50.50 and 39.78. In testing the time spent by the 3-monthers looking at the male and female faces, a Wilcoxon matched-pairs signed ranks test was performed; this test revealed significantly more looking at the female face by these infants, $T = 27$, $p < .02$.

Discussion

Perhaps the most important findings of the present study involve comparisons between the 3- and 6-month-old groups. In general, these comparisons support the conclusion that, by six months of age, infants are capable of matching male and female characteristics across the visual and auditory modalities. These findings are certainly consistent with earlier research on the bimodal integration of featural stimuli (e.g., Cohen, 1974; Spelke & Owsley, 1979). Still, they suggest

(as does this earlier research) that this integration manifests itself later than the bimodal coordination of spatial and temporal stimuli.

There are several possible explanations for these apparent age differences in the bimodal processing of featural as opposed to spatial and temporal stimuli. First, each of the studies discussed above which has examined featural integration across modalities has utilized human stimuli; as a result, the failure of younger infants to demonstrate this integration may result from difficulties in distinguishing among faces. Although this possibility is consistent with previous research on visual perception (e.g., Cohen, DeLoache & Pearl, 1977; Fagan, 1972), it does not seem likely in the current study given the 3-monthers' significant preference for the female face. Another interpretation is that, as Spelke (1979) has suggested, bimodal perception of different stimulus properties may be achieved in different ways. For example, some types of bimodal perception have an innate basis while others are more a function of experience with the environment.

In this regard, the present data are important with respect to what they suggest concerning theories of the origins of infant bimodal organization. Specifically, one approach maintains that we acquire such information in a "component" style (i.e., we first assign meaning to auditory and visual stimuli separately before putting this information together). A second position, closely associated with the work of the Gibsons, (e.g., Gibson, 1966) asserts that bimodal perception is a much more integrative process than suggested by the first view, with infants typically processing bimodal information as a single event. Although the present study did not directly address this issue, previous research does indicate that infants discriminate between

male and female voices as early as 8 weeks of age (Culp & Horowitz), and distinguish between male and female faces by 6 months (Cornell, 1974). The present study's findings, in conjunction with this earlier information, appear to support the component approach to bimodal organization, at least with respect to human stimulus configurations.

In contrast to the 6-month-old subjects, the 9-monthers in the present study did not match male and female voices to their corresponding faces. While we might conclude that the infants were incapable of such matching, these results are probably more a function of the experimental procedure which was employed. Specifically, it should be noted that the 9-month-olds spent less overall time looking at either of the stimuli. This fact, together with the large attrition rate in the 9-month group, suggests that this particular paradigm may not have been appropriate with infants who are this old; such a conclusion only substantiates the importance of utilizing methods which "fit" the infant.

Despite this problem, it is interesting to note that these 9-month-old infants actually looked more at the opposite-sex face under the male and female voice conditions; this was particularly true for the female face during the male voice condition. While these differences were not significant, they at least imply that other factors, such as novelty, may serve to mediate the bimodal organization of older infants. Further, while previous research has primarily focused upon this organization in the first year of life, it may be valuable to examine this issue after this time, employing appropriate experimental paradigms.

Some final comments involve findings from previous research which indicate that infants tend to "prefer" male or female stimulus characteristics. For example, as discussed earlier, Francis et al. (1980) reported that 3-month-olds were observed to look more at the female face regardless of the auditory condition; in contrast, Miller and Horowitz (1980) found that 8-monthers exhibited more visual fixation to male facial configurations. While the present study of 3-, 6-, and 9-monthers failed to confirm the "shift" that might be expected from these earlier studies, the current sample of 3-month-olds did demonstrate a preference for the female faces across auditory conditions. While direct information on this issue is lacking, clearly the most reasonable explanation involves the parent with whom the infant spends more time; for example, all of the 3-monthers in this sample had their mother as the primary caregiver.

In conclusion, the present study demonstrates the ability of infants, by the sixth month of life, to recognize male and female stimulus configurations across the auditory and visual modalities. While 9-monthers did not exhibit such recognition, it is suggested that more appropriate paradigms might be utilized with infants this age. Further, future research on bimodal processing might use older infants than have been traditionally utilized in such research; In this way, other factors, such as stimulus novelty, may be found to play a role in the processing of bimodal information.

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Table 1

Age X Auditory Condition Interaction-Time Spent Looking at Male Face (In Seconds)

		Auditory Condition		
		Female Voice	Male Voice	Music
Age (In Months)	3	22.83	20.83	26.83
	6	21.33	35.50	23.67
	9	23.33	20.33	18.33

Table 2

Age X Auditory Condition Interaction-Time Spent Looking at Female Face (In Seconds)

		Auditory Condition		
		Female Voice	Male Voice	Music
Age (In Months)	3	26.17	27.33	29.67
	6	31.67	15.33	24.00
	9	17.33	23.00	17.00